

# Instruction Manual

## Fisher Proportional Temperature Control

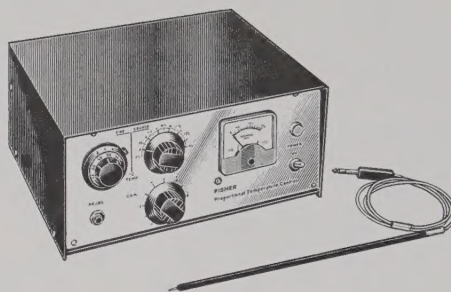
Catalog No. 15-177-50 & -51

(49)





**FISHER** Proportional Temperature Control



## SPECIFICATIONS

### POWER REQUIREMENTS

Cat. No. 15-177-50

115V, 50-60 Hz, 15A.

Cat. No. 15-177-51

230V, 50-60 Hz, 7 1/2A

### TEMPERATURE RANGE

0° to 250°C

### SENSITIVITY

10% Change in Output for 0.01°C  
Change in Bath Temperature

### TEMPERATURE CONTROL

0.01°C

### TEMPERATURE SETTING REPRODUCIBILITY

±0.02°C

### OUTPUT

750 Watts Maximum Controlled &  
750 Watts Maximum Not Controlled

## GENERAL DESCRIPTION

The Fisher Proportional Temperature Control is designed to be used as a precise and reliable temperature controller for laboratory constant temperature baths. Using the proper Temperature Probe it can be used to control a bath at any temperature between 0 and 250°C. Because the Proportional Temperature Control operates in a fully proportional manner, it allows for much closer and more uniform temperature control than is possible with conventional on-off controllers.

## PRINCIPLES OF OPERATION

The usual method of bath control involves the turning on and off of a heater in response to a thermostat. This results in temperature "overshoot" and "undershoot" and consequently poorer bath control. In an attempt to minimize bath fluctuation by this control method, two heaters are usually used in the bath. One high-wattage heater is on continuously to compensate for the steady heat loss of the bath, while a lower-wattage heater is cycled on and off in response to a thermostat.

With the Fisher Proportional Temperature Control, power is continuously applied to a single heater. However, the amount of power to the heater is constantly changing in order to maintain the bath at a preset temperature. A sensitive thermistor probe in the bath medium senses the smallest deviation of the temperature from the set point. The error signal produced is fed to a silicon controlled rectifier circuit which increases or decreases the power to the heater, as necessary, to maintain the desired temperature. The sensitivity of the thermistor probe, together with the fast response of the electronic circuit, makes the temperature control provided by the controller stepless and extremely uniform and constant. (A more complete description of the circuit operation is given in the Appendix on page 4.)

## UNPACKING

Carefully unpack the Proportional Temperature Control and check the items against the packing list below. If any are

| <u>Quantity</u> |                                  | <u>Number</u> |
|-----------------|----------------------------------|---------------|
| 1               | Proportional Temperature Control |               |
|                 | 115V, 50-60 Hz                   | 11460         |
|                 | 230V 50-60 Hz                    | 25294         |
| 1               | Warranty Card                    | 01001         |
| 1               | Instruction Manual               | 15037         |

## OPERATING CONTROLS

The few simple operating controls are located on the front panel:

**POWER SWITCH** — This toggle switch controls power to the instrument's circuitry. The pilot lamp directly above the switch glows when the power is on.

**METER** — This volt meter indicates the a-c voltage being supplied at any given time to the heater plugged into the instrument's circuitry.

**TEMPERATURE CONTROLS** — These two controls — fine and coarse — are used to preset the desired temperature of the bath medium. The coarse control is divided into six segments — A through F — each calibrated for 25°C. This range is for use with the standard Temperature Probe (Fisher Catalog No. 15-177-55). A special High Temperature Probe (Catalog No. 15-177-57) covers the range of 80° to 250°C.

The fine control is a 10-turn Duodial that can be read to the nearest hundredth. These are arbitrary numbers with no actual temperature value, and are used for very precise temperature setting and control.

**GAIN CONTROL** — This control is essentially a sensitivity adjustment for the instrument. Its exact adjustment depends upon factors such as whether the bath medium is oil or water, what the set temperature is, and what the rate of stirring is. If set too high, the power to the heater (as indicated by the panel meter) will fluctuate widely in an on-off manner. The correct setting is indicated by the needle of the panel meter oscillating around some voltage above zero.

In addition to these controls, the back panel of the instrument contains four 3 prong a-c outlets. The two power outlets are controlled by the control circuitry and will handle two heaters not totalling more than 750 watts. The other two are convenience a-c outlets into which a stirrer or similar devices can be plugged.

## OPERATING PROCEDURE

1. Assemble a bath such as the Fisher Unitized Constant Temperature Bath (see Fisher Catalog) using a 750 watt heater, a stirrer and a thermometer. Water can be used as a bath medium for temperatures up to 70°C, but clear bath oil (Fisher Catalog No. O-5) should be used from 70° to 105°C. For temperatures above 105°C, a silicone oil must be used. If temperatures around ambient or below are desired, a cooling coil must also be inserted into the bath.
2. Plug the heater into either of the controlled outlets on the

back of the Proportional Temperature Control.

3. Insert the Temperature Probe into the bath so that its tip is as near to the heater as possible. Determine which way the bath medium is stirred and locate the probe down stream from the heater. Plug the Temperature Probe into the jack on the panel of the controller.
4. Turn on the Power Switch, and set the Gain Control to mid-range.
5. With the stirrer running, set the Coarse Temperature Control for the general range of temperature desired and set the fine control to 5.00. As the bath approaches the desired temperature, increase or decrease the Fine Temperature Control until the bath thermometer reads exactly the temperature desired.

NOTE: The Coarse Temperature Control is calibrated in 25°C segments for use with the Model 8 Low Temperature Probe (15-177-55) with a range of 0° to 150°C. When using the Model 9 High Temperature Probe (15-177-57) with a range of 80° to 250°C, the segments of the Coarse Temperature Control cover the following ranges:

| Segment | Temperature°C |
|---------|---------------|
| A       | 76 - 105      |
| B       | 91 - 120      |
| C       | 115 - 152     |
| D       | 144 - 185     |
| E       | 177 - 222     |
| F       | 207 - 260     |

6. When the bath has reached the desired operating temperature, observe the panel voltmeter. The needle will probably be cycling widely from 0 to 115 volts indicating an on-off control action rather than proportional control. If this is the case, decrease the setting of the gain control until the meter needle hovers around some voltage between 0 and 115 volts. This will be the point of true proportional control. If the voltmeter needle does not cycle at all between 0 and 115 volts once the bath has reached the desired temperature, the Gain Control should then be turned up until the needle does cycle. Once the cycling does begin, back off on the Gain Control until the needle oscillates around some voltage.
7. After the gain has been adjusted properly, it may be necessary to readjust slightly the Fine Temperature Control to bring the bath to the desired temperature. The panel voltmeter will always indicate the voltage being applied to the heater. As mentioned the meter needle will normally oscillate around some voltage between 0 and 115 volts when the bath is at temperature equilibrium. However, when a cool object is introduced into the bath, the voltage will rise to make up for the heat loss, but should soon fall again to its normal equilibrium value.

## ACCESSORIES

| <u>Item</u>                            | <u>Catalog No.</u> |
|----------------------------------------|--------------------|
| Fisher Temperature Probe, 0° to 150°C  | 15-177-55          |
| Fisher Temperature Probe, 80° to 250°C | 15-177-57          |

## REPLACEMENT PARTS (See Figure 1)

| <u>Symbol</u> | <u>Item</u>                                      | <u>Number</u>  |       |
|---------------|--------------------------------------------------|----------------|-------|
|               |                                                  | OLD            | NEW*  |
| T1            | Power Transformer                                | 15-177-50-018  | 12244 |
| T2            | Input Transformer                                | 15-177-50-016  | 12242 |
| T3            | Pulse Transformer                                | 15-177-50-017  | 12243 |
| F1            | Fuse, 15A, 250V, 3AB                             | FU-1-12        | 10860 |
| M1            | Meter (115V)                                     | 15-177-50-0175 | 12231 |
|               | Meter (230V)                                     | 15-177-50-0185 | 12232 |
| S1            | Power Switch, SPST                               | 13-991-80-013  | 01630 |
| S2            | Temperature Range Switch                         | 15-177-50-083  | 12275 |
| R9            | Potentiometer, 1K, 10 Turn                       | 15-177-50-078  | 12272 |
| R22           | Gain Control Potentiometer                       | 15-177-50-079  | 12273 |
| Q1, 10        | Transistor, 2N2270                               | 15-177-50-067  | 00935 |
| Q2, 3, 4, 8   | Transistor, 2N1307                               | -----          | 06052 |
| Q9            | Unijunction Transistor 2N1671A                   | 15-177-50-071  | 01636 |
| Q5, 6, 7, 11  | Transistor, 2N3904                               | -----          | 01066 |
| CR1, 2        | Silicon Controlled Rectifier,<br>Motorola 2N4172 | -----          | 23909 |
| RE1, 2, 3, 4  | Rectifier, 500MA                                 | 11-134-283     | 00931 |
| RE5           | Zener Diode                                      | 15-177-50-074  | 12270 |
| RE6           | Zener Diode                                      | 15-177-50-076  | 12271 |
| J1, 2         | Convenience Outlet, 115V                         | J-02           | 08595 |
|               | Convenience Outlet, 230V                         | J-06           | 08598 |
| P1            | Line Cord, 115V                                  | LC-8           | 07103 |
|               | Line Cord, 230V                                  | LC-7           | 09172 |
| PL1           | Pilot Light, 115V                                | PL-08-1W       | 08979 |
|               | Pilot Light, 230V                                | PL-08-2W       | 11814 |
| J3            | Phone Jack                                       | 15-177-50-082  | 12274 |

\*Use new number when ordering replacement parts.

## APPENDIX

### DESCRIPTION OF CIRCUIT OPERATION

The Fisher Proportional Temperature Control circuit (see Figure 1) functions as follows: The thermistor probe forms one arm of a 60 cycle a-c bridge circuit. Also included in the bridge is the temperature range switch for selecting one of six precision resistors, together with a ten turn potentiometer used as a fine temperature-setting control. When the temperature of the bath is equal to the preset temperature, the output of the bridge is zero. However, when there is a difference in temperature, a small a-c signal proportional to the difference is produced across the output transformer T2 of the bridge. This signal is fed to an amplifier consisting of transistors Q1 through Q5 where it is amplified.

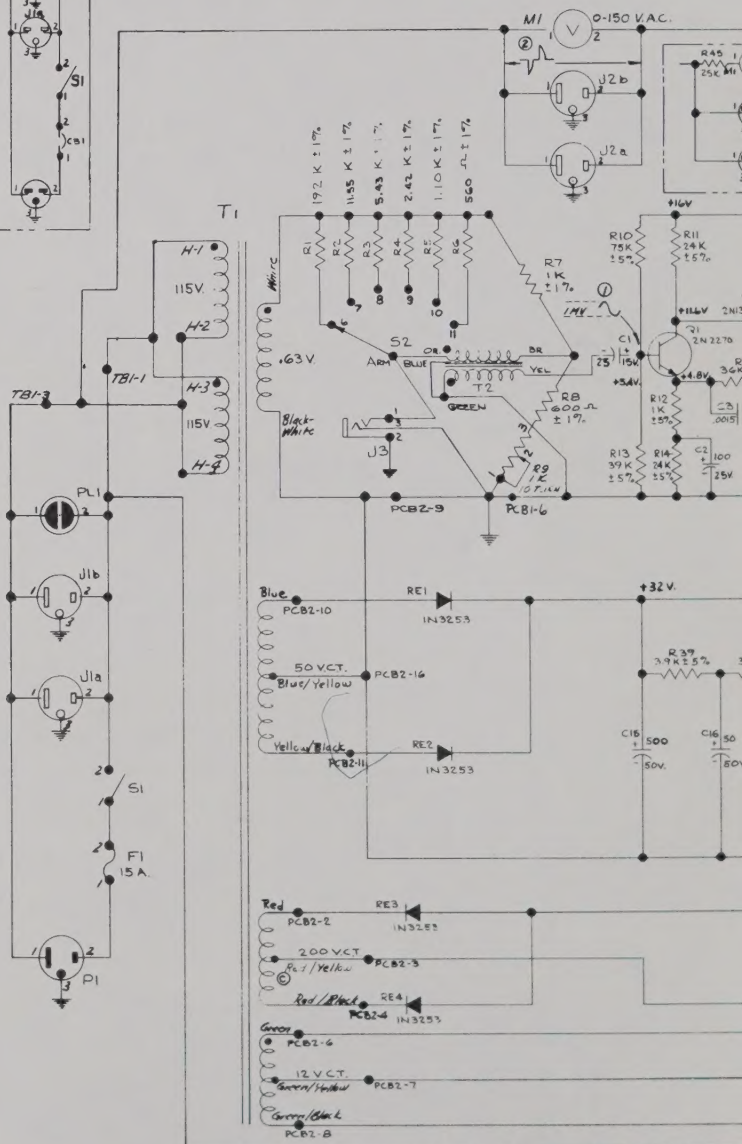
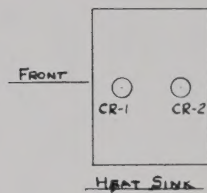
Transistors Q6 and Q7 form a demodulator which converts the a-c signal from the output of the amplifier to a proportional d-c signal. The output of the demodulator appears across R-30, and polarity is negative when the bath is below the set temperature and positive when above.

The d-c signal from the output of the demodulator controls the operation of the output stage of the Proportional Temperature Control. This stage consists of Transistor Q8, unijunction Transistor Q9 and two silicon controlled rectifiers CR1 and CR2.

The silicon controlled rectifiers are arranged in series with the heater so that conduction can take place during both half cycles of the a-c line voltage. The SCR's are not conductive until a "trigger" signal is applied to their gates. Once triggered they will continue to conduct like a thyatron until the anode-to-cathode potential is interrupted or is reduced to zero. In this circuit, the one or the other SCR is rendered non-conducting on each half cycle when the a-c voltage falls to zero.

The trigger pulse is supplied to the SCR's gates through Transformer T3. The source of the pulses is a relaxation oscillator using the unijunction Transistor Q9. The magnitude of the off balance voltage from the demodulator controls the conductance of Transistor Q8 and, therefore, the amount of current through R35 which charges capacitor C14. When the potential across the capacitor reaches the emitter peak-point voltage of the unijunction transistor, C14 is discharged through Q9 and the primary of T1. A pulse is generated which turns on the SCR with the positive anode. At the end of the power line half cycle, the SCR turns off.

The time delay between the beginning of the half cycle and the trigger pulse determines for what fraction of time the SCR will conduct and the load will receive current. If the bath temperature is below the set temperature, the output of the demodulator becomes more negative, the current through R-35 increases, and the trigger pulse is generated sooner in the half cycle, increasing the power to the heater as required. As the set temperature is approached, the trigger pulses come later and later in the half cycle decreasing the power to the heater. In this way full proportional control of the power to the heater is attained.











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